graphic effects in magnetotellurics. Results from a sinusoidal surface were compared with calculations obtained by a Rayleigh perturbation approach, physical optics, and a rigorous integral equation method. These comparisons together with self-consistent error criteria which measure the degree to which the boundary conditions are matched have established the validity of the modified Rayleigh approach. No limit on surface height has been apparent but the method does suffer where surface slopes are large. Even so, valid results have been obtained from sinusoidal surfaces having amplitudes of 500 m with a maximum slope of 45 degrees. Tests were made for periods ranging from 0.1 to 1000 sec using model resistivity values between 10 and 1000 Ω-m.

As expected, topographic effects are more pronounced at shorter periods and in more conductive terrain. Transverse electric (TE) results yield apparent resistivity increases over sinusoidal highs that exceed ten percent. For example, with a sinusoidal surface of 500 m amplitude and maximum slope of 45 degrees, a high value of 141 Ω-m occurs over the surface peaks at $T = 0.1$ sec when the true half-space resistivity is 100 Ω-m. This topographic effect decreases to a peak value of only 102 Ω-m for $T = 1000$ sec.

The tests have established the modified Rayleigh method as well-suited for evaluating topographic effects in magnetotellurics. The computer implementation is fast and efficient and has been extended to arbitrary topography with a buried rough layer. The method has been used to estimate topographic effects in a magnetotelluric survey conducted in the vicinity of Socorro, New Mexico where contemporaneous magma bodies are inferred at depths as shallow as 5 km.

Scale Model Experiments as an Aid in Interpretation of EM Survey Data   M2.3

C. J. Villegas-Garcia*, J. C. MacNae, and G. F. West, Univ. of Toronto

In the last 30 years, scale model experiments have proved to be a very useful tool in electromagnetic methods applied to mineral exploration. Perhaps the most important application, in the interpretation of EM survey data concerns, is the generation of type and characteristics curves, particularly for those simple models not amenable to analytical or computational solutions. However, as many field geophysicists are aware there are many cases where the geometry of ground conductors is so complex that the interpretation obtained with those sets of type and characteristic curves is far away to appear as optimum, leaving unanswered key questions about the detected conductor and in consequence, setting up a rick in the next step to be given into the normal exploration procedures. Such a step sometimes is a drill hole or a follow-up survey with another system or other geophysical method but anyone of these choices translates to several thousand dollars in expenses.

We present a procedure with scale model experiments that may provide answers to those interpretation problems. This procedure has proved to come up with quick answers in a very efficient way, since we are able to do scale modeling semi-automatically in a computer controlled laboratory. The first step in the procedure is to construct a scale model using the initial interpretation as a starting point. The EM survey is then repeated at the correct (geometrical and electrical) scale over this model. Using the model data, the initial interpretation can then be refined, and a new scale model constructed and surveyed. The procedure can be interacted until the field data are adequately matched by the model response. We also display two examples of case histories where we hope to show the kinds of problems scale modeling can solve in interpretation and the kinds of answers it can provide.

A Versatile EM Scale Modeling System   M2.4

H. F. Morrison, A. J. Clarke*, W. D. Hansen, and A. Becker, Univ. of California, Berkeley

An automated electromagnetic scale modeling facility has been de-signed and developed and is presently in operation at the Univ. of California, Richmond field station. Models are located within a 9 by 16 ft wooden tank of 6 ft depth over which a fully automated universal coil mount carriage translates in the horizontal and vertical directions. In addition, target positioning is automated with respect to depth, and multiple target configurations are possible due to a variety of target support mechanisms. Low noise measurements are made possible by a continuous electronic cable support which maintains constant geometry and tension within the cables. The facility is presently set up to model conventional airborne coaxial systems and a superconducting unicoil system. The scale factors used are: geometrical 1/300; conductivity 1200; frequency 75. The scale model instrumentation is centered on the Ithaco 393 phase lock amplifier. A Hewlett Packard 9825A minicomputer and HP6940B multiprogrammer serve for data acquisition and provide control over the vertical and horizontal position of the coil system. Scan rates are up to $\sim$ 1 cm/sec at noise levels of better than 0.5 ppm of the primary field. To monitor performance prior to a data scan, the system is calibrated against analytical data for a large highly conductive horizontal sheet.

The model studied is composed of a vertical rectangular block overlain by a horizontal tabular overburden immersed in a conductive half-space. A new method of obtaining the necessary conductivity and homogeneity for the target has been developed utilizing high pressure cure of expoxy-grafite composites. Uniform conductivities ranging from 100 to 4000 mho/m have been obtained, and a comprehensive program of modeling the above configuration has been carried out. This program includes real frequencies of 30 to 300 Hz, resistivities of 1, 10, and 100 Ω-m for target, overburden, and half-space, respectively, and profile altitudes of 20 to 70 m. In addition, target depth, presence of overburden, and half-space conductivity are also varied. Illustrative data for several of the above model configurations is included which demonstrates the ability of the facility to provide high quality scale modeling information.

Integral Equations Electromagnetic Modeling of 3-D Bodies in a Layered Earth   M2.5

Philip E. Wannamaker* and Gerald W. Hohmann, Univ. of Utah

With a few exceptions concerning bodies beneath an overburden layer, numerical simulations of the electromagnetic responses of 3-D buried structures have been confined to inhomogeneities in uniform half-space hosts. The importance of overburden layers in determining EM signatures over potential ore deposits has been recognized by mining geophysicists for years. In addition, large scale resistivity structures such as valley sediments or magma chambers, or importance in crust-mantle or geothermal investigations, reside in a regional resistivity layering determined by the physiochemical conditions of the particular tectonic environment. To illuminate special characteristics of EM scattering associated with bodies in layered earths, we have generalized an existing integral equations algorithm previously used to model inhomogeneities in half-spaces.

In the integral equations approach, a 3-D inhomogeneity is replaced by an equivalent scattering current defined in terms of the geometry and resistivity values of the body and its layered host. The 3-D body is discretized into rectangularly prismatic cells over each of which the vector scattering current is approximated by a constant. The elements of the impedance matrix, which is inverted to obtain the scattering current in each cell, are constructed from tensor Green's functions specifying the electric field at $\bar{r}$ due to a current dipole at $\bar{r}'$ within a given layered earth. From the resulting scattering currents, scattered electric and magnetic fields at the surface may be computed, again using the appropriate layered earth Green's functions.

The layered Green's functions were derived using Debye vector potentials. Within the layer containing the source, the Green's functions are defined using primary or whole space and secondary components, the former are analytic expressions while the latter are expressed in terms of Hankel transforms. In layers external to the source, the functions are defined using secondary components only,